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THE AUGUST METEORS.

By W. H. S. Monck.

One of the best-known meteor-showers of the year is that which attains its maximum about August 9–11, and has latterly been usually known as the *Perseids*. Since the publication of Schiaparelli's paper on the subject over 20 years ago, the shower has been supposed to be caused by Comet iii, 1862, the node of whose orbit is reached by the earth on August 10, the cometary radiant being computed at 43° R. A. 57½° N. Decl. by Prof. A. S. Herschel, and at 43°.8 R. A. 57°.2 N. Decl. by Mr. Corrigan. Mr. Denning, indeed, who is probably the best living observer in this department, has made several statements which appear to be inconsistent with the cometary theory, but which have attracted but little attention. The shower, according to him, commences as early as July 8, from a radiant situated at 3° R. A., 49° N. Decl., and terminates about August 22, with a radiant at 78° R. A., 57° N. Decl., there having been a continuous shifting of the radiant during this interval. The high inclination of the comet's orbit to the ecliptic seems inconsistent with the long continuance of the shower, and a few of Mr. Denning's figures, which were submitted to the test of computation by Mr. Corrigan (in *The Sidereal Messenger*) showed that, if the English observer was correct, the true radiant of the shower must have shifted even more rapidly than the apparent radiant. This is not a very satisfactory state of things, though in the latest English Text-book (Chambers') I find both Schiaparelli's and Denning's theories accepted without comment.

It occurred to me that a historical examination of the facts might tend to clear up some of the difficulties connected with them, but the following sketch is not, of course, intended as a complete one; and, in particular, I do not touch on American observations, because other members of the Society are much more competent to deal with them than I am.

It is only in comparatively recent times that the fact that the meteors in any particular shower usually proceed from a common radiant point has been recognized. Consequently, earlier observations are of very little use, except as showing that there is no agreement in period between that of the comet (computed at 123 years) and the maxima of the meteor-shower. One of the earliest notes that I have met with as to the radiant-point of the August shower is by the late Mr. E. J. LOWE, a very careful observer. Writing to the late Professor BADEN POWELL, who then supplied reports on the subject to the British Association, in 1849, Mr. LOWE says:

"The meteors seen in 1839 diverged from a point situated between *Taurus* and *Pegasus.* Since then the point is stated to be near β *Camelopardalis.* Both last year (1848) and this year (1849), from a great number of observations the point was in, or slightly above, *Casseiopeia*, from the 9th to the 18th of August; but, strange to say, until then this point was not observed. There was another situated in *Cygnus*, which had been plainly discerned since the middle of July. From that time until the 9th of August, if the paths of the meteors were produced backwards, they would nearly all meet at a point situated on the east of α *Cygni*, and on the 10th they were all near the star α. The number of stars seen on the 10th was about 80, the sky being clear for an hour, from shortly before 10 o'clock to near 11 o'clock. Fifty-five of these meteors had their paths and other features recorded here. Out of this number are those noticed proceeding from the direction of these two points of divergence.

From *Cygnus*	23
From *Casseiopeia*	26
Discordant	6
	55

IN 1848.

From *Casseiopeia*	8
From *Cygnus*	5
	13"

The essential point of this letter is that, though there was a fair display of meteors in 1849, none of them came from what may be called the cometary radiant in *Perseus*, and that, in this respect, they agreed with the August meteors previously observed by Mr. LOWE from 1839 onwards.

It was not, indeed, until 1855 that Mr. LOWE noticed *any* August meteors from a radiant in *Perseus.* On the 4th of September in that year he writes to Professor BADEN POWELL:

"On producing the paths of their course backwards, several points of divergence were well-shown on the 9th, 10th, 12th and 13th [of August]. The one most apparent was ½° above and 2° N. of α *Persei;* the second well-shown was 2° N. of the cluster of stars in the sword-hand of *Perseus;* a third immediately under *Casseiopeia,* and a fourth below χ *Cygni.* The points of divergence in *Casseiopeia* and *Cygnus* were noticed in former years, but the two in *Perseus* were not seen until 1855, and I cannot help thinking that the meteors in other years (that I have observed) did not show these points of divergence in *Perseus.*" And Mr. LOWE proceeds to call the attention of other observers to this fact, but I do not find from Professor BADEN POWELL'S reports that any one claimed to have discovered the radiants in *Perseus* previous to 1855. It will be seen, moreover, that Mr. LOWE speaks of two radiants in *Perseus,* and that neither of them are situated very near the cometary radiant at 43°+57½°. It is not until several years later that I find Mr. LOWE placing the principal radiant of the August shower (for that year) near η *Persei.*

Professor HEIS was pursuing a similar course of observation in Germany about the same time, and somewhat later Dr. SCHMIDT observed this and other showers at Athens. Abstracts of HEIS' and SCHMIDT'S Catalogues are given in the British Association Reports for 1878, but they do not distinguish between the earlier and later observations, which are here important. I find, however, a summary of the observations of both these distinguished astronomers on the August showers in a valuable paper by Colonel (then Captain) TUPMAN, published, I believe, in the year 1872. The results are as follows: 1. Both HEIS and SCHMIDT did not find a single radiant, but a number of distinct radiants. 2. The radiants determined by HEIS do not agree, in position, with those determined by SCHMIDT. 3. Neither HEIS nor SCHMIDT discovered any radiant situated within some degrees of the cometary radiant at 43°+57½°. SCHMIDT, indeed, evidently detected such a radiant at a later period than that to which TUPMAN refers, for in his Catalogue in the British Association Reports for 1878, I find one at 46°+55° for the epoch August 3–10. HEIS, however, has still no radiant nearer than 45°+50° for the epoch August 1–24.

I ought not to pass over the Catalogue published by the late Mr. R. P. GREG in the British Association Reports for 1868. It is founded, at least in part, on the observations published in these Reports during the preceding 20 years, and it contains a radiant at 44°+56° for the period July 28–Aug. 16. Mr. GREG, however, does not give the particulars of the observations from which this radiant was deduced, and it had been found by Mr. LOWE in England, as well as by Italian observers used by SCHIAPARELLI previous to 1868.

The next investigator to whom I shall refer is Colonel Tupman, whose observations were made in the Mediterranean in the years 1869, 1870 and 1871. Colonel Tupman, like Mr. Lowe, observed that the meteors came from several radiants, which were simultaneously active, and this led him to compare his own observations with those of others, of which he gives a table. From his observations on Aug. 8–10, 1869, he deduced four radiants at 50°+56°, 42°+64°, 50°+63° and 47½°+58°, respectively. On the 11th, besides repeating two of these positions, he obtained a new one at 39°+65°. He then gives a large number of results obtained by others, including those of Heis and Schmidt, already alluded to. Professor Parnisetti, for Aug. 10–11, 1869, obtained three radiants at 23°+57°, 26°+57° and 61°+43°, respectively. Lorenzoni, for almost the same date, obtained three at 26°+62°, 58°+58° and 37°+46°. Neither of these observers seem to have obtained the cometary radiant at all. Tacchini and Denza, on the other hand, obtained it, but not alone. Tacchini obtained an additional radiant at 27°.8+62°, and Denza an additional radiant at 35°+60°. With regard to the observations of Parnisetti, Lorenzoni and Tacchini, I may notice that Konkoly also found a radiant at 24°+59° for the period July 27–Aug. 9, in Hungary. Altogether, Tupman's own observations, and the compilation of those of others which he has made, strongly suggest a radiant area of considerable extent, the points of maximum display varying with the conditions of time and place—a conclusion already favored by the observations of Mr. Lowe. Tupman's observations, after his return to England, confirmed the theory of distinct centres of activity.

After these observations of Col. Tupman, Mr. Denning of Bristol becomes the most distinguished English observer, though not without many able co-workers. His earlier observations were entirely favorable to the theory of several simultaneous centres of activity, but I cannot say how far he has altered the views which he then expressed, since his adoption of the theory of continuous shifting. On the 10th of August, 1878, he observed two well-marked radiants at 44°+59° and 42½°+54°, respectively. An erroneous computation of the radiant point of Comet i, 1870, which had been published by Prof. A. S. Herschel, led him to ascribe the latter radiant to it, and, to obtain further evidence on the point, he reduced the Italian observations of 1872. The result was the detection of three distinct radiants at 47°+58°, 42°+52° and 33°+57°, respectively. When the error of Herschel's computation was corrected, it appeared that the second of these radiants could have no connection with the comet in question, but its existence was not the less evident. The third radiant, Mr. Denning's notes, agrees with one already deduced by Prof. Herschel from observations on Aug. 9, 10, 11. "The three positions," he adds, "are each confirmed by stationary meteors. On August 5, 1864, Heis records one at 44°+57°, and on August 9, 1850, at 43°+53°, and at Bristol, on Aug. 8, 1876, one was seen at 35°+57°." (*Observatory*, vol. ii, p. 165.) Mr. Denning adds, in the article which I am quoting, that "the diffuse radiation hitherto observed on August 10 is entirely due to the fact of several temporary showers lying near together, about B *Camelopardi*, γ *Persei* and χ *Persei*, supplying meteors of the same visible features in common." This theory of several simultaneous radiants seem, indeed, to be the only alternative to the theory of a radiant area; but it may be doubted whether the several radiants are as accurately defined as we should expect them to be on this supposition. Thus, in this very year, 1878, Schrader found a radiant at 32°+57° on the 10th of August. Mr. Denning repeats his assertion of a number of distinct radiants in simultaneous action in *The Observatory* for the following year (vol. iii, p. 117), and I am not aware how far he still adheres to it. At all events, it is far from resting on his authority alone. To cite one other able observer. On the 4th of August, 1880, Mr. Corder noted two radiants, one at 35°+56° and the other at 46°+57°. He had noticed the former on the 1st of August, and he noticed the latter, without substantial change, on the 6th, 8th, 9th and 11th. The published observations of Mr. Denning, Mr. Booth and others, afford examples of two or more radiants distant from each other by several degrees, having been observed on the same day in this region of the sky. I mention this chiefly because it seems to me to be inconsistent with the continuous shifting of the radiant which Mr. Denning now advocates. Meteors continue to come to us from points which, according to him, the shifting radiant has passed, and they even come to us from points which, in his opinion, the shifting radiant has not yet reached. For example, he obtained a radiant at 43°+58°, on the 31st of July, when the R. A. of his shifting radiant is 10° less than this.

Most of the members of this Society are aware of Mr. Denning's discovery (for such, I think, it must be called), of stationary, or long-enduring radiants. Meteors come to us from almost the same point in the heavens for months, or even for the whole year, in succession. Now, it is worth noticing that the radiant point of the 3d comet of

1862 agrees almost exactly with the position of one of these stationary or long-enduring radiants which sends us meteors (though in diminished numbers) when we are at a great distance from the comet's node. This was almost announced by Mr. Denning in the year 1887, though his theory of the shifting radiant seems to have afterwards induced him to abandon it. In *The Observatory* (vol. x., p. 299), after describing a shower from 40°+56° in June as "swift, bright streaks, *Perseids*," he adds: "The first of these is new for the epoch, and the position nearly agrees with the great *Perseid* radiant on Aug. 10. There are many additional showers here in the summer and autumnal months; for amongst my previous observations I find the following radiants, which are well confirmed by some other determinations, which I also quote:

Observed at Bristol.		Other Observers.	
Epoch.	Radiant.	Radiant.	Epoch.
1878, July 26–31,	43°+58°		
1879, Aug. 20,	40°+59°	42°+62°,	Aug. 13, Sept. 30 (Heis)
		42°+55°,	Sept. 5, 1870 (Tupman)
1885, Oct. 6–16,	42°+55°	47°+56°,	Oct. 3–Nov. 14 (Heis)
1877, Oct. 8–14,	43°+58°		
1879, Oct. 14,	48°+60°		
1877, Nov. 4–7	45°+60°	40°+60°,	Nov. 13, 1868 (S and Z)
1885, Dec. 1–10,	44°+55°	45°+56°,	Nov. 23, Dec. 18 (G and H)

I have also seen traces of showers from nearly the same point at other times of the year."

Mr. Denning's late Catalogue contains a radiant at 44°+56°, on the 29th of November. In 1879 he determined a radiant at 45°+57°, from 23 meteors, between Aug. 24 and Sept. 14. In *The Observatory* for 1888, when, noting an Italian stationary meteor at 49°+58°, on July 8, he remarks, "which seems to show that there is a shower of *Perseids* more than a month before the August display" (vol. xi., p. 97.) His examination of the Italian observations of 1872 led him to conclude that the activity of the radiant had continued duting the last five months of the year. It will be seen that these figures differ from each other by some degrees, but that is a common feature of all observations on this radiant, and suggests that the true radiant is rather an area than a point. Moreover, the majority of the observations on Aug. 10 indicate for the radiant on that day a R. A. exceeding by about 3° that of the cometary radiant. The declinations agree fairly.

It may, perhaps, be thought that a stationary radiant at 44°+56°

(or thereabouts) is hardly consistent with the theory of a radiant area. But the fact appears to be that other points within this area exhibit the same continued activity. Thus, Mr. DENNING observed a fine shower from a radiant at 32°+53°, at the end of July, 1878, which he then distinguished from the main *Perseid* shower, but afterwards identified with it. He noticed others at 32°+50° on Aug. 14–23, at 33°+54° on Sept. 6–9, at 31°+52° on Sept. 21–25, and at 32°+50° on Oct. 8. HEIS finds one at 31°+55° in the month of January, and SCHMIDT finds the same radiant for Aug. 3–12. On the whole, I think the theory of a radiant area is the most probable one, but the evidence at present is hardly sufficient to distinguish between it and the theory of a number of radiant points simultaneously active, some being more prominent than others, in particular years. But neither of these views seem to be reconcilable with the cometary theory as usually understood.

As to Mr. DENNING's theory of the continued shifting of the radiant, though he asserts it very positively, the evidence adduced in its favor seems very weak. There are large gaps in his published observations, and he has himself observed meteors coming from the earlier positions long after the shifting radiant has (according to his theory) passed beyond them. His first position is at 3°+49° on July 8. SCHIAPARELLI found a radiant at this precise point on July 31, and Mr. DENNING noticed meteors from very near it to later in July, and again in August. His next position is at 11°+48°, on July 11, 14. He obtained a radiant at 11°+47° from a larger number of similar meteors about three weeks later. His third position is at 19°+51°, on July 19. HEIS obtained a radiant at 19°+52°, for August 1–6. Mr. DENNING may have unpublished observations which tend to establish a continuous shifting from 3°+49°, on the 8th of July, to 78°+57° on the 22d of August, but as far as the evidence has been published his case is extremely unsatisfactory—except, perhaps, for three or four days before and after the maximum on Aug. 10.

There is a curious connection between the radiant of these August meteors and that of the November *Andromedes* which are usually traced to BIELA's comet. It will be seen that Mr. DENNING found meteors coming from a radiant at 44°+56° on Nov. 29 and Dec. 1, almost contemporaneously with the BIELA shower. He also obtained meteors from substantially the BIELA radiant on August 4–10, and again on Aug. 12–16, during the continuance of the *Perseid* shower. And both showers appear to remain active during the entire period between August and November. Mr. DEN-

NING obtained radiants at 24°+42° on Aug. 20–25, at 28°+45° on Sept. 4–16, and at 25°+44° on Oct. 14, 15. HEIS gives a radiant at 24°+42° for the period Oct. 17–Nov. 23, and Mr. DENNING deduced from Italian observations one at 25°+44° on Feb. 13. It seems to be generally admitted that this BIELA radiant is an area, and that the figures only represent its central point; and it will be noted that, taking 25°+44° for its central point, it is not very remote from the radiant *Perseid* just discussed at 32°+53°. But almost the whole intervening space appears to be covered with radiants, thus throwing the two areas into one. Mr. DENNING observed a BIELA radiant at 29°+46° on the 27th of Nov. He obtained radiants at 30°+46° and 31°+49° in August, and he deduced one at 30°+47° from Italian observations in July. Are such radiants as these three to be classed as *Perseids* or as *Andromedes?* They seem to me rather to show that the two showers are connected together, and that whenever we meet with meteors belonging to the one system, we may look with confidence for those belonging to the other.

To sum up briefly the results at which I have arrived:

1. The August meteors do not come from a single radiant, but from several radiants which are simultaneously active, and some of which are situated at a considerable distance from the cometary radiant.

2. These simultaneous radiants do not occupy the same positions every year or even in the same year, when observations are made at different places, but they are all comprised within an area, which may therefore be regarded as a radiant area.

3. Meteors come from the principal radiant situated at about 44°+56° (and from other points within the radiant area) both before and after the maximum display in August, and the activity of the principal radiant, in fact, lasts from June to December.

4. Meteors come from the radiant area of *Andromeda*, which gives a fine display of meteors about Nov. 27th, simultaneously with the meteors from the radiant area in *Perseus*, and these two radiant areas, in fact, run into each other and cannot be separated.

5. There is no continuous shifting of the radiant; and if the activity of the western portions of the radiant area is more marked during the earlier part of the display, and that of the eastern during its later developments, the activity of the former does not cease when that of the latter becomes conspicuous, but both are simultaneously active.

These features of the display seem to be inconsistent with the cometary theory as usually held. Whether they can be explained by a family of comets (most of them hitherto unobserved) I leave to be considered. The entire subject is well worthy of attention, both by observers and by theorists.

ADDENDUM.

Since writing the foregoing I have examined HEIS' list of meteors observed by him, amounting to over 12,000, published in the year 1877. He refers them to the various radiants determined by himself and others, and gives these determinations for each two consecutive days at the end of July and beginning of August, and for each day when near the 10th. The results may be thus summarized: In no case did the *Perseid* meteors appear to proceed from a single radiant (the usual number being three or four), and the most active radiant was situated near the cometary one only on the two days, Aug. 3 and 4. On these days 27 meteors were traced to a radiant at 47°+56°, and 5 to a radiant at 44°+57°, the other active radiants for this date being 18°+50° (20 meteors) and 25°+58° (11 meteors). On some other days a radiant at 45°+52°, or 45°+51° takes the lead; but on the 10th of August—the date of the maximum display—the principal radiant, according to HEIS, is at 25°+58°, which is supported by 116 meteors, followed by 11°+60° with 80 meteors, 45°+52° with 77 meteors and 40°+55° with 53 meteors. On the 11th the largest display is again from 25°+58°, the radiant at 45°+51° coming in second, while on the 12th the radiant at 45°+51° becomes the most active. I can find no trace of the shifting of the radiant in HEIS' figures. It is curious that the radiant at 25°+58°, which contributed so largely to former displays, seems to have been almost unnoticed of late years. A radiant at 40°+45° is active during most of the period referred to.